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Chromosome Aberrations in the Holocentric Chromosomes of *Philosamia ricini* (Saturnidae)

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Abstract. The nature of chromosome aberrations was studied in F_1 male progeny of irradiated male parents. Translocation rings (0.34%), chains (3.7%) and fragments (15.9%) were found. Translocation chains outnumbered the frequency of rings and appear to be produced from the latter by dissociation of chiasma. Dissociation of more than one chiasmata produces bivalents and monovalents indistinguishable from the parental ones. Fragments were transmitted to the F_1 offsprings stabily. Inversions were rare.

Introduction

Chromosome aberrations in the holocentric chromosomes usually behave in a different pattern from those in monocentrics: fragments are frequent and are stabily transmitted through several generations (Tempelaar, 1979). The nature of observed rearrangements of holocentric chromosomes in structural hybrids are, however, still doubtful (White, 1973) and to date reports on such aberrations in Lepidoptera are almost lacking. This perhaps is due to the isodiametric, numerous, much smaller holocentric chromosomes. In view of the above parameters the present study was undertaken with *Philosamia ricini* using ^{60}Co gamma ray source as the inducing agent.

Methods and Material

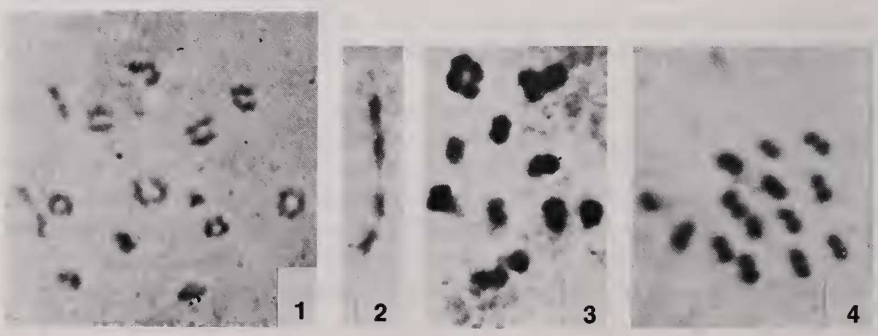
Adult males of *P. ricini*, were irradiated with an acute dose of ^{60}Co gamma ray (dose rate, 165.5 R/min.). They were held for 24 hours and then mated to virgin females. The F_1 male offspring were examined for meiotic chromosomal rearrangements. Cytological preparations were stained by an improved Orcein-Giemsa (OG) technique. Slides were observed and photographed using high power light microscopy.

Results

Spontaneous chromosome aberrations have been rarely observed in this species. However, preparations of chromosomes of the F_1 male progeny obtained from the crosses of the irradiated male parent revealed the translocation rings, chains and fragments during the first spermatocytic phase

(Padhy, 1983). Chromosomal translocations of chains (Fig. 2) and rings (Fig. 3) included reciprocal exchanges of segments between non-homologous chromosomes of the irradiated parent. These formed synapses and chiasmata, usually terminally, characteristic in the Lepidoptera (Fig. 1). Such reciprocal translocations have also been reported in the mite *Tetranichus utricae* (Tempelaar, 1979). Terminalisation of chiasmata was also seen in the translocated chromosomes. Terminalization of one of the chiasmata of a tetravalent ring (Fig. 3) could result in a straight chain of four (two exchanged) chromosomes with three chiaqsmata intervened among them (Fig. 2). This structure is frequently noticed (Fig. 4). In the meiotic spermatocytes bearing the reciprocal translocations of the F_1, the number of bivalents was reduced to 12 (n=14, Fig. 4) or less, excluding the translocation tetravalent. The translocation chains, however, cannot result from either fragmentation or differential condensation of chromatin material because such events were not observed in the gamma irradiated meiotic preparations of the male parent studied after 12, 24, 48 hour intervals (Padhy, 1983).

As is clear from Table 1, translocation chains (3.7%) were more frequent than the translocation rings (0.34%) and are thus about ten times more frequent. This result indicates a rapid terminalisation of one of the chiasmata of the tetravalent before metaphase I (Fig. 5A). Rapid terminalization of two chiasmata could give rise to two bivalents each attached by a single chiasma in between (Fig. 5B). These cannot morphologically be differentiated from normal bivalents and therefore pass undetected. The third type (Fig. 5C) indicates a chain of three chromosomes attached by two chiasma which come across in F_1 meiosis. The other complement appears



Figs. 1 and 4. Normal diakinesis and metaphase I in spermatocytes.

Fig. 2. Translocation chain in a diakinesis spermatocyte of the F_1 male from the gamma irradiated male parent. Two exchanged and two nonexchanged chromosomes remain associated by the intervening chiasmata.

Fig. 3. Metaphase I spermatocyte of the F_1 male progeny of the gamma irradiated male parent. Arrow indicates the translocation quadrivalent with a chromosome complement of 13 bivalents.

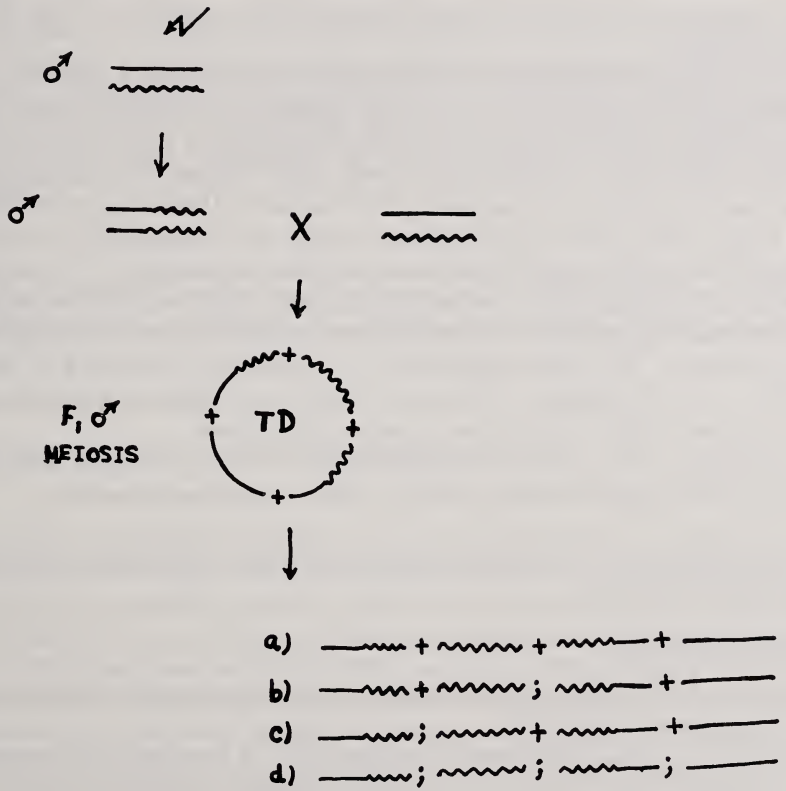


Fig. 5. Mating protocol of the irradiated male *P. ricini* crossed to a normal female. F_1 male meiosis indicates a translocation ring during diakinesis. This could possibly give rise to four types of chromosome associations by the chiasma: a) chains of four, b) chains of two, c) chains of three and one, and d) four univalents.
+ = chiasma points, ↙ = irradiated, TD = translocation during diakinesis

Table 1. Frequency of aberrations in the F_1 male progeny of the gamma irradiated male parents of *P. ricini*.

Stage	Cells Observed	Translocation Rings N	Translocation Chains N	Total Translocations (%)	Fragments N
diplotene-diakinesis	140	2	16	12.8	24
metaphase I	740	1	17	2.4	44
Total	880	3 (0.34%)	33 (3.7%)	—	68 (15.9%)
Control	1000	—	—	—	—

as a fragment or univalent. An association of four univalents (Fig. 5D) is also possible.

The occasional appearance of univalents were noticed in many of the translocated spermatocytes, but these could not be differentiated from normal monovalents relative to the dissociation of a single bivalent.

The percentage of translocations was more frequent in late prophase spermatocytes than in metaphase. The reasons for this are given in Figure 5B which shows that translocations cannot be differentiated morphologically from the normal complements during metaphase I. This abnormality in the formation of chiasmata might partly be due to intragenic alterations and partly due to the absence of a centromere in lepidopteran chromosomes. The latter explanation is supported by the work of Bauer (1967) in the Lepidoptera, Murakami and Imai (1974) in *Bombyx mori* and Cooper (1972) in the mite *Siteropsis graminum*.

Fragments were, however, transmitted to the F_1 structural hybrid in 15.9% of the spermatocytes (Padhy, 1983). Inversions were rare.

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